WHAT IGNORING LIME CAN DO TO CORN AND SOYBEANS [1/]

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As early as the late 1800s, scientists recognized differences in crop responses to added lime. Since that time, numerous researchers have substantiated and expanded these findings, by suggesting that both corn and soybean are more acid tolerant than alfalfa. For example, in 1964 Doll in Michigan recommended pH ranges for corn to be 5.5 to 7.5, soybean 6.0 to 7.0, and alfalfa 6.3 to 7.8. When Woodruff (1972) reviewed the Midwestern literature published prior tot he early 1970s, he noted that corn generally did not respond to lime unless the pH was 5.0 or less. Furthermore, Woodruff stated that where lime responses were seen, there did not appear to be a benefit from higher rates of application. This early work did not specifically review any soybean experiments; however, it is clear that like those for corn, responses are soil type and location specific.

From the late 1800s to the 1980s, the dominant agriculture in Wisconsin was oriented around dairying and forages. With alfalfa being quite acid sensitive, the lime needs of the corn and soybeans raised as rotation crops were rarely an issue. However, in the last 10 years, there has been a substan-tial shift on many acres to continuous grain. Lime has been forgotten or ignored as a production input and soil pH on some fields has dropped to startlingly low levels.

Some Case Studies

This past summer I was asked to investigate several fields in south-central Wisconsin, mostly on sandy loam to loam soils that had been in continuous corn or corn-soybean rotation for the past several years. In every case, the growth of the crop was severely impaired in some parts of the field. In some cases, the poorer growth areas were associated with parts of the field that had less soil organic matter, but in other fields the poor growth appeared to be related to inadequate or possibly excessive overlapping of the application of some input.

Table 1 shows the soil and plant analysis results from three of the fields we investigated and just the soil test results from two others. As can be seen, every one of these fields had several characteristics in common: pH less than 4.5, generally moderate soil organic matter and soil test K levels, and excessive levels of Mn in the plant tissue in the abnormal parts of the field. Interestingly, the better-looking areas of the fields only showed pH about 0.5 pH unit higher and these would still be at levels we believe are less than optimum for raising corn or soybeans. In the one case where a plant sample was taken from a good or more-normal area, the tissue Mn level was much lower (224 ppm) but still borderline toxic for sensitive crops such as soybeans. Although the corps in these areas looked much better, they likely would have performed even better at recommended pH levels.

Clearly the underlying problem on all of these fields is an inadequate liming program.

[1/] Portions of this work were funded by the Wis. Liming Materials Council, the Wis. Fertilizer Research Council, and the UW College of Agricultural and Life Sciences and are gratefully acknowledged.

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Table 1. Soil test and plant analysis results from several 2003 Wisconsin fields

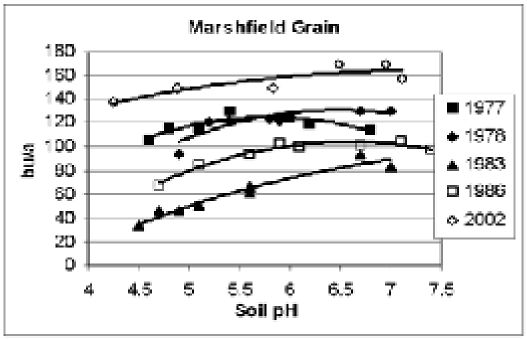
		Soil test			Plant analysis				
Field	pH	Organic matter	P	K	N	P	K	Ca	Mn
		%	----- ppm	-----	-------------------	%	-----------------------		ppm
1	4.4	1.0	64	91					
2	4.3	1.3	158	80					
3-bad	4.6	2.0	183	139					
3-good	4.9	3.0	191	120	4.79	0.43	2.43	1.54	1254
4-bad	3.9	0.9	104	84	4.34	0.32	1.25	2.27	224
4-good	4.5	0.9	75	83	2.17	0.63	2.94	0.30	1306
5-1	3.8	1.0	174	104	2.98	0.29	2.18	0.15	958
5-2	3.8	1.3	144	78	2.74	0.42	2.51	0.17	409
5-good	4.9	1.6	69	71					

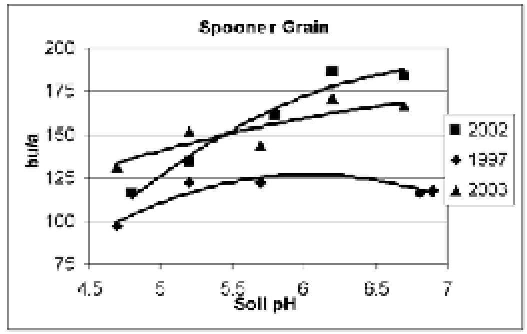
Lime Needs of Corn and Soybeans

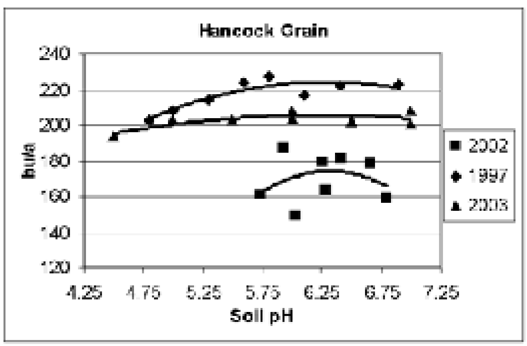
Wisconsin has conducted several liming experiments that have examined the responsiveness of corn and soybeans to pH changes. Figures 1 through 4 show the grain yield responses for corn associated with increasing pH from about 4.5 to 7.0. On the somewhat poorly drained silt loams in the Marshfield area, although the yield of grain varied from one year to the next based on weather conditions, it is clear that optimum yields were not obtained unless the pH was 6.5 or above. In those years, where yields appear to be a bit greater at the higher pH levels, this response may be related to earlier maturity where lime had been applied (Fig. 1). Work in Wisconsin has shown that in some years that corn silked as much as one week earlier as pH was increased from 5.0 to 6.1 (Powell, 1975). In general, the yield responses ranged from about 25 to 40% increase as the pH was brought into the optimum range. Responses at Spooner (Fig. 3) were generally similar with relative yields increasing 20 to 40% and optimum yields occurring about pH 6.3 or above.

Results from Hancock and Arlington are somewhat less dramatic in that yield increases at Hancock were only about 10% and were only to about pH 6.0, and at Arlington increases were even more modest. These results emphasize the location/soil differences that can occur. One reason for the smaller response at Arlington and Hancock is the lower levels of available and total Mn in these soils. Under acid conditions, much less Mn is taken into the plant and toxic levels are not reached. For example, at a pH of 4.6, ear leaf Mn levels at Marshfield were almost 400 ppm, but only 260 pm at Arlington at the same pH.

Fewer Wisconsin liming experiments have been done with soybeans; however, in 1984 several soybean varieties were grown at pH levels from 4.6 to 6.5 at Marshfield and 4.6 to 7.1 at Arlington (Gritton et al., 1985). In general, all of the varieties responded similarly. Therefore, the results presented in Table 2 are the averages for each pH level at each site. These data also show yield benefits to liming to at least 6.3.







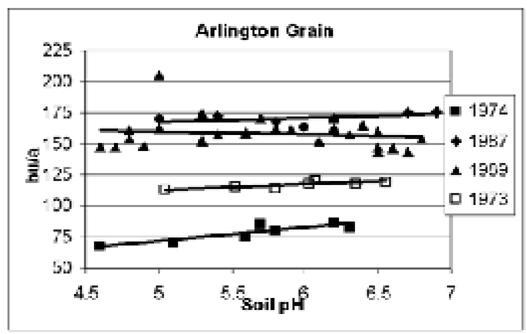


Table 2. Soybean response to soil pH at Marshfield and Arlington, WI, 1984.†

Soil pH	Marshfield	Arlington
	-------------------- bu/acre ------------------	
-		
4.5	17.3	
4.7	22.7	38.0
4.9	22.1	
5.1		
5.3	29.5	38.8
5.5		
5.7		38.8
5.9		
6.1		
6.3	32.1	39.7
6.5		
6.9		
7.1		43.4

† Average of four varieties at each location (adapted from Gritton et al., 1985).

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